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From: Commander, Dahlgren Division, Naval Surface Warfare Center
To; Commander, Naval Ammunition Logistics Center
Main Rd., Bldg. 1959, Room 129
Attn: Louise Carlson
Yorktown, VA 23691-0410

Subj: HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO)
SAFETY EVALUATION OF THE PDT-7200 AND UPD-1000 AUTOMATED
INFORMATION TECHNOLOGY (AIT) EQUIPMENT

Ref: (a) MIL-STD-461D Requirements for the Control of
Electromagnetic Interference Emissions and
Susceptibility
(b) MIL-STD-462D Measurement of Electromagnetic
Interference Characteristics

Encl: (1) HERO Safety Evaluation Test Results for the PDT-7200
and UPD-1000 Automated Information Technology (AIT)
Equipments

1. As requested by NALC/Ms. Louise Carlson, HERO safety evaluation tests were conducted during the period of 15 through 19 November 1999, on the PDT-7200 Bar Code Reader and the UPD-1000 Memory Button Reader Automated Information Technology equipments (here-in-after referred to as AIT equipment). The evaluations, for each item, were based on the results of an analysis of the radiated emissions spectrum characterization. Radiated Emission (RE102) tests were first conducted to the requirements of reference (a) in order to determine the bandwidth and magnitude of potential emissions. Where appropriate, the tests were accomplished in accordance with the procedures specified in reference (b). The AIT equipments subjected to test and evaluation were as follows:

a. Symbol PDT-7200-RII60M01 Bar Code Scanner S/N ALPHA9451.

b. Symbol UPD-1000 Memory Button Reader S/N UP00118.

2. The results of the radiated emissions spectrum analysis, RE102 tests, as well as the conclusions and recommendations which are based on those results are presented in enclosure (1).

3. Please direct any questions, or comments, to Benton C. Zander Code J52, commercial (540) 653-3435 or DSN 249-3435.

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SAFETY EVALUATION OF THE PDT-7200 AND UPD-1000 AUTOMATED
INFORMATION TECHNOLOGY (AIT) EQUIPMENT

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HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE
(HERO) SAFETY EVALUATION TEST RESULTS
FOR THE
PDT-7200 AND UPD-1000
AUTOMATIC INFORMATION TECHNOLOGY (AIT)
EQUIPMENT

November 1999

Distribution authorized to DOD personnel and DOD Contractors only; Test and Evaluation; November 1999. Other request for this document must be referred to Commander, Dahlgren Division, Naval Surface Warfare Center, Code J52, 17320 Dahlgren Road, Dahlgren, Virginia 22448-5100

Enclosure (1)

**. HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO) SAFETY
EVALUATION FOR THE PDT-7200 AND UPD-1000 AUTOMATED INFORMATION
TECHNOLOGY (AIT) EQUIPMENT**

Ref: (a) MIL-STD-461D
(b) MIL-STD-462D
(c) Hazards of Electromagnetic Radiation to Ordnance (HERO)
Safety Evaluation Test Results for the PDT-7200 and
UPD-1000 Automatic Information Technology (AIT)
Equipment

I. GENERAL

1. During the period of 15 November through 19 November, tests and analysis were performed to determine the radiated emissions spectrum characteristics of two items of Automated Information Technology (AIT) equipment. The tests, to determine the radiated emissions spectrum characteristics of the AIT equipments were conducted as a means of evaluating the safety of using these AIT equipments in the proximity of ordnance. Radiated Emissions (RE102) tests and evaluations were first conducted to determine the bandwidth and magnitude of potential emissions, and the potential for the AIT equipments to affect the operation of other sensitive electronic equipments. The RE102 tests were conducted to the extent possible, as specified in the requirements and procedures delineated in references (a) and (b). The tests were conducted in accordance with reference (c), which is included as attachment (1) for information purposes.

2. The AIT equipments evaluated were as follows:

a. Symbol PDT-7200-R1160M01 Bar Code Scanner S/N ALPHA9451.

b. Symbol UPD-1000 Memory Button Reader S/N UP00118.

3. Although the AIT equipments subjected to tests and evaluation are not intentional emitters, they are intended for use in the proximity of ordnance items. In the case of the PDT-7200, it was determined that it would normally be operated at a distance of 4 to 12 inches from ordnance items to scan bar code labels. The UPD-1000 "reads" Memory Buttons, which are attached to ordnance shipping containers and/or ordnance items, via a relatively short cable and probe. Therefore, it was considered essential that the safe separation distance for each AIT item be determined.

4. The Electro-Explosive Devices (EED)s used in Navy ordnance vary considerably (depending upon the application) in the Maximum No Fire Stimulus (MNFS) that they can withstand without firing. MIL-STD-464, DEPARTMENT OF DEFENSE INTERFACE STANDARD, Electromagnetic Environmental Effects Requirements for Systems, states that "Ordnance shall have a margin of at least 16.5 dB of maximum no-fire stimulus (MNFS) for safety assurances and 6 dB of MNFS for other applications." This requirement categorizes RF currents induced in an EED which exceed 15 percent of the MNFS as being a potential safety concern, and 50 percent of the MNFS as being a potential reliability concern.

5. Since some EEDs may have a "Maximum No Fire Current" (MNFC) of as low as 30 mA, it is essential that the MNFC, or MNFS of ordnance in the area be given due consideration before operating any electronic/electrical equipment, or intentional transmitter in the proximity of the ordnance. If this information is unknown at the time of the operation, it should be assumed that the ordnance in the inventory area contains the most sensitive EED (those requiring the lowest MNFC or MNFS).

II. TEST CONFIGURATION

1. **RE102 Test Configuration:** All of the AIT equipments were subjected to the RE102 test requirements of reference (a) as a precursor to the radiated emissions spectrum analysis. The test configuration required by reference (b) was modified to more closely reflect the manner in which the AIT equipment would be configured and used in the field. For example the ground plane (copper top bench) was not used for this testing, since the AIT equipments tested are portable. However, RE102 measurements were taken at a distance of one meter with any cables to/from the AIT equipment under test arranged in such a manner as to allow lengths of cable representing a significant portion of a wavelength, at the unit's operating frequency, to be included in the measurements.

The PDT-7200 was placed in a cradle, and operated manually to scan a bar code label during the RE102 measurement efforts.

The data from the UPD-1000 can also be read by the PDT-7200 via an Infra-Red (IR) port in the base of the handle of the PDT-7200. Therefore, during these tests, it was necessary to program the PDT-7200 to repeatedly gather the data from UPD-1000, and direct it to continuously re-read the memory button.

2. **Radiated Emissions Spectrum Characterization Configuration:** A special antenna test fixture, which had been constructed to facilitate the analysis of the output signal

spectrum characteristics of AIT equipments, was utilized for these efforts. The antenna test fixture, here-in-after referred to as "the fixture," was designed and constructed to establish a fixed measurement distance, between the radiating item and the receptor antennas, of either four inches or twelve inches. The fixture consists of a .125" x 14" x 21" aluminum plate, with three antenna ports set at four and twelve inches apart. The aluminum plate is mounted on 1 3/4 inch wood spacers to allow space beneath the plate for the connection of low-loss cables to/from the antenna ports, and to the spectrum analyzer.

For the analysis, the PDT-7200 was operated manually to repeatedly scan a bar code label. The UPD-1000 operation was commanded by the PDT-7200, which was programmed to direct the UPD to download it's data and re-read the Memory Button.

The RE102 test configurations for the PDT-7200 and the UPD-1000 are shown in figures 1 and 2. The same configurations of the AIT equipments were used for the radiated emissions spectrum analysis.

Figure 1. PDT-7200 configured for RE102 tests.

Figure 2. UPD-1000 configured for RE102 tests.

III. TEST METHODOLOGY

1. **RE102 Tests:** These tests were conducted, to the extent possible, in accordance with the requirements of reference (b). The PDT-7200 and UPD-1000 were both subjected to RE102 emissions measurements in accordance with reference (b), to establish a baseline for analysis of the radiated emissions spectrum characterization, and determine their potential affect on other sensitive electronic equipments. For these measurements, the PDT-7200 was operated manually to scan a bar code label. The configuration of the AIT equipments for these tests were as described in section II, paragraph 1, above.

2. **Radiated Emissions Spectrum Characterization:** For these efforts, the PDT-7200 and UPD-1000 configuration were as described in paragraph II.2. All losses in the measurement system equipment setup, such as cable, connectors, and connector adapter losses were determined and recorded prior to making any measurements. This was accomplished by substituting a HP8648D RF Signal Generator for the equipments under test (EUT)s, as the RF signal source, and measuring the loss resulting from all interconnecting cables and connectors to be used between the receive antenna and the HP8566B spectrum analyzer.

Prior to conducting this characterization and analysis, the RE102 measurement plots were examined to identify the frequencies at which the radiated emissions may be of concern. Quarter wavelength antennas were then cut for those frequencies, and measurements were made at distances from one meter to four (4) inches, or until the safe separation distance for each AIT unit was identified. The configuration of the AIT equipments for these tests were as described in section II, paragraph 2. above.

IV. TEST RESULTS AND DISCUSSION

1. **RE102 Test Results:**

a. **Symbol PDT-7200-R1160M01 Bar Code Scanner S/N ALPHA9451.** When measured from a distance of one meter, the radiated emissions from the Symbol PDT-7200 exceeded the

acceptable RE102 limits of reference (a) at 66.25 MHz. The highest level of radiated emissions, which exceeded the RE102 limit at this frequency was found to be 39.0 dBuV/m (or approximately 2 dBuV/m above the RE102 limit). The plots portraying the radiated emissions measured at one meter from this unit are provided in Attachment (2).

b. Symbol UPD-1000 Memory Button Reader S/N UP00118.
When measured from a distance of one meter, the radiated emissions from the Symbol UPD-1000 exceeded the acceptable RE102 limits of reference (a) in the frequency range of 56 MHz to 152 MHz. The highest level of radiated emissions, which exceeded the RE102 limit was found to be 51.7 dBuV/m [or approximately 14 dBuV/m above the acceptable RE102 limits of reference (a)] recorded at 56.4 MHz. The plots portraying the radiated emissions measured at one meter from this unit are provided in Attachment (2).

2. Radiated Emissions Spectrum Analysis Results

a. Symbol PDT-7200-R1160M01 Bar Code Scanner S/N ALPHA9451. When measured at a distance of four (4) inches, the highest level of radiated emissions from this unit was found to be 22.8 dBuV, recorded at a frequency of 66.294 MHz. The worst case radiated emissions spectrum characteristics of this unit at four (4) inches is presented in plot (007) in Attachment (3).

b. Symbol UPD-1000 Memory Button Reader S/N UP00118.
When measured at a distance of four (4) inches, the highest radiated emissions from this unit were found to be 16.3 dBuV, recorded at a frequency of 56.822 MHz, and 22.9 dBuV at a frequency of 113.638 MHz. The worst case radiated emissions spectrum characteristics of this unit at four (4) inches are presented in plot (009) and (010) in Attachment (3).

The memory buttons can be mounted directly on ordnance containers and/or ordnance items, and the UPD-1000 probe is attached on to the memory button to "read" the inventory data. Therefore, we considered it essential that a measurement be obtained with the measuring antenna nearly touching the probe. The results of the measurement with the antenna just a fraction of an inch from the probe was an emissions level of 36.5 dBuV at a frequency of 113.638 MHz. The worst case radiated emissions spectrum characteristics of this unit in this configuration is presented in plot (012) in Attachment (3).

V. RECOMMENDATIONS

1. Recommendations are made with consideration to the RE102 test

results, and the radiated emissions spectrum analysis. The measured RE102 levels for both the PDT-7200 and the UPD-1000 were well below the magnitude necessary to be considered a potential hazard to ordnance at a distance of one meter, however do indicate that the units may affect the operation of other sensitive electronic equipment. The following recommendations for each item tested are presented individually:

- a.** The PDT-7200, as tested, should not be considered as presenting a hazard to ordnance, when operated at distances of four (4) inches or greater from ordnance.
- b.** The UPD-1000, as tested, should not be considered as presenting a hazard to ordnance during normal inventory operations.
- c.** Neither the PDT-7200 nor the UPD-1000 should be considered as suitable for use in the Shipboard EM environment of the Fleet, without first being subjected to, and passing Radiated Susceptibility (RS103) test and evaluation to the requirements of reference (a).

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RADIATED EMISSIONS (RE102-2) PLOTS
OF
SYMBOL PDT-7200 AND UPD-1000 (AIT) EQUIPMENT

Attachment (2)

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RADIATED EMISSIONS SPECTRUM CHARACTERISTICS PLOTS
OF
SYMBOL PDT-7200 AND UPD-1000 (AIT) EQUIPMENT

Attachment (3)